The PROGRESSIVE FISH-CULTURIST

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UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF FISHERIES
WASHINGTON

PROGRESSIVE FISH-CULTURIST

ISSUED BY

UNITED STATES DEPARTMENT OF THE INTERIOR - - - - - - - - - HAROLD L. ICKES, SECRETARY
BUREAU OF FISHERIES - - - - - - - - - - - - - CHARLES E. JACKSON, ACTING COMMISSIONER

A SERIAL memorandum published occasionally for the advancement of fish-culture and fishery management in fresh waters.

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The PROGRESSIVE FISH-CULTURIST
News and Views from many Sources on Practical Hatchery Problems

Memorandum I-131 Washington, D. C. March - April 1940 No. 49

LOST : 10,839 FINGERLING TROUT !

AN APPRAISAL OF THE RESULTS OF PLANTING FINGERLING TROUT
IN ST. MARY RIVER, VIRGINIA

By Eugene W. Surber
U. S. Fisheries Experimental Station
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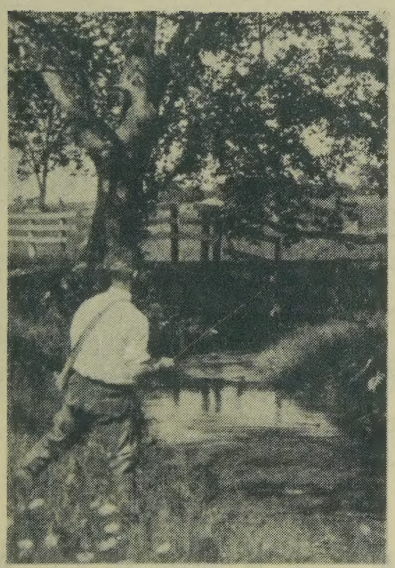

IT HAS BEEN obvious to many fish-culturists and anglers that the planting of fingerling trout has not brought results commensurate with the number planted. Although this matter has been the subject of investigation only recently, the facts were sufficiently obvious to lead fish-culturists to experiment with the rearing of trout to legal size, with results that were immediately popular. The present as well as other recent studies indicate that in certain cases the planting of fingerling trout has produced results poorer than was imagined possible. This suggests an unfitness for survival probably brought about to a considerable extent by common hatchery methods. Results in streams rich in food have been nearly as poor as in streams such as St. Mary River, which is only average in this respect. The planting of fry or fingerling trout will no doubt continue in remote sections, but if the results reported here are typical - and it becomes more and more apparent that they are - then we should either abandon the planting of trout fingerlings in populous sections or discover methods of producing fingerlings better adapted for survival. The major objective of this study has been to follow up a series of plantings of fingerling trout to determine how many of the planted fish finally reached anglers' creels.

DESCRIPTION OF ST. MARY RIVER

The St. Mary River is one of the better trout streams in the George Washington National Forest, Augusta County, Virginia. It arises from small seepage springs and flows through a narrow, very rocky, uninhabited mountain ravine (figure 1). The stream flows over a boulder-strewn rubble and gravel bed of quartzite,

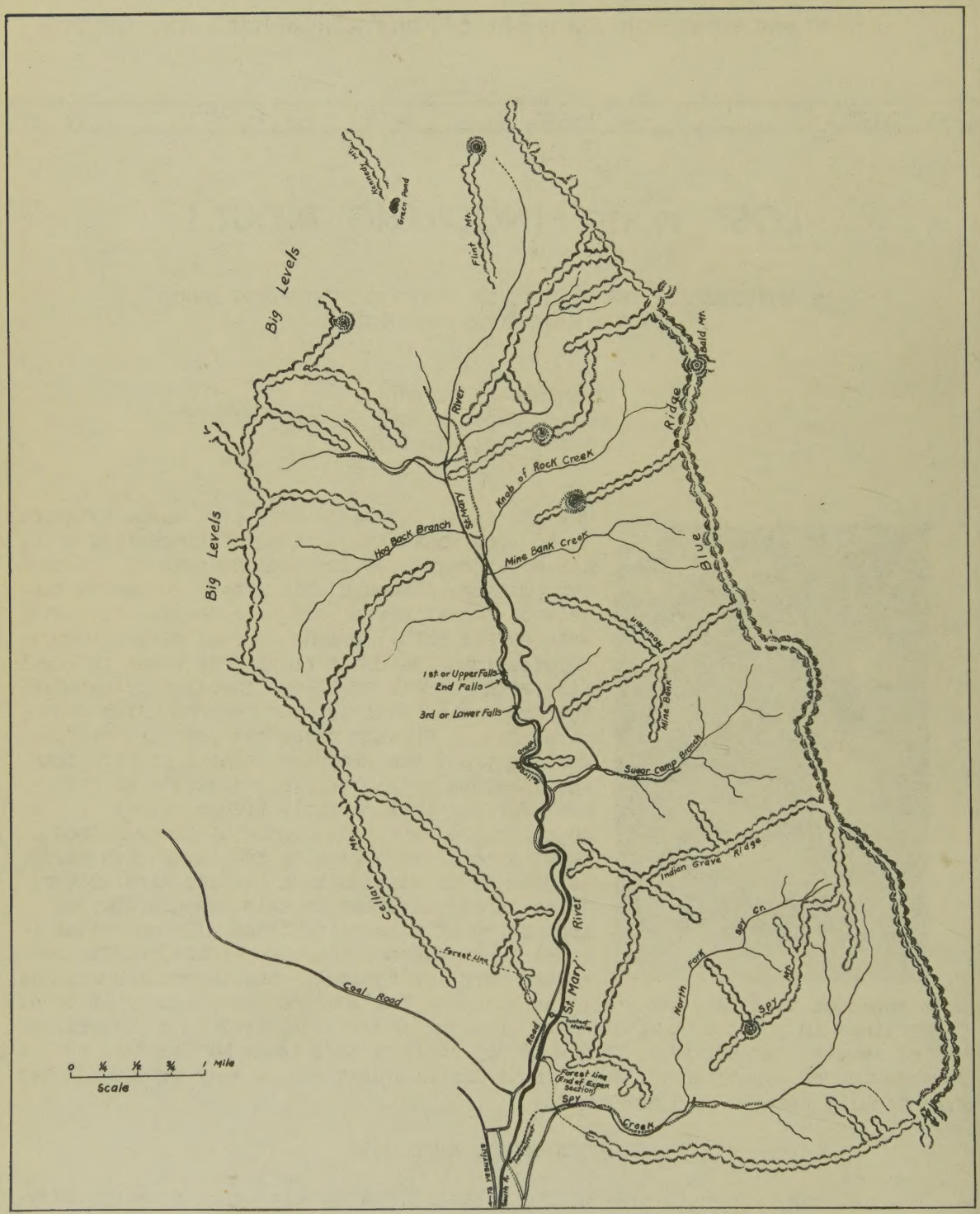

Figure 1. Map of St. Mary River

apparently dissolving little of the elements conducive to good biological production. During 1938 the average methyl-orange alkalinity was 4.69 parts per million, pH 6.8, free carbon dioxide content 3.1 parts per million. The stream has very soft water and is slightly acid. The average width as reported by McGavock and Davis[1] on May 17, 1938, was 9 feet from the forest line (end of experimental section) to Mine Bank (on map, just above Mine Bank Creek). From this point to its source, the stream averaged 7 feet in width. On that date the flow was estimated at 7.9 cubic feet per second in the lower section and 4.3 cubic feet per second in the upper section. The gradient of the stream is 150 feet per mile in the lower section, 175 feet per mile in the upper. The survey party making the original survey gave the stream a pool grade of B which is above average

Figure 2. St. Mary River with its canopy of overhanging alders. The checking station was located near this point.

for the Forest as a whole. It remains clear even following heavy showers, and on the whole maintains a better flow than the majority of the streams in the George Washington National Forest area.

The experimental section of St. Mary River included all of the main stream from the forest line (and game management area boundary) to the source. Only a short section of the stream, about three-fourths of a mile in length, lying between the forest line and the mouth of Spy Creek is not included. St. Mary River and Spy Creek converge to form South River, a tributary of the James River.

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[1] McGavock, Alfred M. and H. S. Davis.
1935. A survey of the streams of the George Washington National Forest. Bureau of Fisheries mimeographed report, March 1935. 29 p.

The river affords better than average natural protection for trout in the form of deep pools and sheltering boulders. It probably contains a full complement of natural trout enemies such as raccoons, mink, and snakes, for the stream is located in a game management area where hunting is prohibited.

Data on temperature conditions obtained with a recording thermometer during the year from October 18, 1936, to October 18, 1937, showed a maximum temperature of 68° F. and mean monthly temperatures of 62.75 in June, 63.20 in July, 64.93 in August, 58.42 in September. Daily variations in temperature even on the warmest days were very small due principally to the narrowness of the mountain ravine through which the stream flows and a canopy of alder bushes over the stream. The

Figure 3. A typical pool in the St. Mary River.

maximum temperature on the warmest days occurred between 3:00 and 5:00 p.m., while the minimum occurred between 3:00 and 6:00 a.m. If we assume that the effective feeding temperature range lies between 47° and 68° F., which seems probable in St. Mary River, there was a total of 231 effective feeding days, or parts of days during the year October 18, 1936, to October 18, 1937. The temperature data collected during the early spring of 1937 show there were only seven days prior to April 15 when trout could have fed sufficiently to grow and improve their condition. This fact is cited as an argument against the opening of a trout season even in this southerly section before May 1.

Beginning August 27, 1935, a series of square-foot bottom samples, 18 to 20 in number, were taken in riffles at monthly intervals, except during the winter, until August 24, 1937. An average wet-weight production of 1.04 grams (dry 0.22

gram) per square foot was recorded for the four months, August, September, October and late November, 1935. During nine months, mid-April to mid-December 1936, the average wet weight of bottom animals was 1.12 grams per square foot (dry 0.28 gram). In 1937, collections were made from April 1 to August 24. The dry weight of the 1937 bottom samples was not determined, but the wet weight averaged 1.06 grams per square foot. Again in 1938, a series of 10 samples per month was collected from March to November. These averaged 1.37 grams per square foot. This average was slightly above that of the 3 previous years, but it serves to give additional evidence that the riffle areas average slightly more than 1.00 gram, wet weight, of potential food organisms per square foot per year. Following the commonly accepted standards of richness, St. Mary River is a Grade 2, or average stream, bordering on the poor.

Figure 4. The author collecting bottom organisms with a square-foot sampler.

The predominating riffle organisms are the caddis larvae of Hydropsyche, Rhyacophila, and Philopotamus, the principal mayfly nymphs Stenonema fuscum, S. varium, S. pulchellum, Paraleptophlebia mollis, Isonychia sadleri, several species of Ephemerella and Baetis. The numerically important stonefly nymphs include species of Leuctra, Alloperla, Acroneuria abnormis and A. lycorias, Perla capitata, Peltoperla arcuata, Pteronarcys proteus and others. Crayfish (Cambarus bartoni) and fish-fly larvae (Chauliodes) often account for a considerable percentage of the bulk of bottom samples. The push-ring cranefly larvae (Eriocera), the snipefly larvae (Atherix), blackfly larvae (Simulium), the omni-present midgefly larvae, and the riffle-beetle larvae of certain parnids make up the bulk of potential fish food organisms. Snails and fish are not abundant.

As yet, insufficient data have been collected concerning the food of trout in this stream to determine in a thorough manner which groups of aquatic organisms

are most important as food. However, examination of 37 brook trout and 14 rainbow trout taken from anglers' catches during the period May 15 to June 15, 1936, revealed the following: (a) there is a numerical predominance of terrestrial over aquatic food animals, (b) crayfish apparently are especially important food organisms, (c) rainbow trout eat quantities of algae (minute, green aquatic plants) which brook trout do not eat,(d) rainbow trout at this time seem to have a greater preference for aquatic forms of food than brook trout, and (e) nematode parasites were abundant in all trout stomachs in the collection. It is not known definitely whether these worms are parasites of the trout or of the insects which they consumed.

It will be necessary to study the food of specimens of trout taken throughout the year before a complete picture can be obtained of the importance of the various aquatic foods. Terrestrial insects contribute a large part of the food taken during the open seasons on trout. This introduces a complicating factor which must be reckoned with in making correlations.

RECORD OF TROUT PLANTINGS IN ST. MARY RIVER AND THE RESULTS

A Bureau of Fisheries party surveyed St. Mary River in 1934 and recommended the stocking of brook trout above the falls and of rainbow trout below. Since there are three falls believed to be barriers to the upstream movement of trout, "above the falls" denotes the area of the stream above the first or uppermost falls. The first and second falls are only a few rods apart. The second falls is the most precipitous. The third falls (figure 5) is located about a half mile below the second. These falls are conveniently located for experimental purposes about mid-way of the fishable section of the stream. The recommendations of the survey party were followed in the plantings made from 1935 to 1937 inclusive. However, observations soon showed that the stream was well adapted to brook trout throughout, and in 1938 the stream was stocked with brook trout only. The plantings are listed in table 1.

In March 1936 a severe flood occurred which apparently removed practically all of the rainbow trout planted the previous year. Following this flood, which did not seriously affect the abundance of bottom animals, brook trout and rainbow trout in larger numbers were again planted in 1936. Table 2 shows the sections stocked and how the numbers planted per mile compare with the number which would have been planted using Embody's[2] stocking policy for a B-1 stream.

The rainbow trout planted during 1936 remained in considerable numbers in the section in which they were placed, yet many had moved downstream by the opening of the trout season April 15, 1937. At that time, a special trip for angling purposes was made to the section of St. Mary River and South River near Vesuvius, Virginia, below the forest line. This section is open to fishing by the public under the general laws of the State. Two persons angling with flies and spinners caught 70 trout on April 16 and 17 in the area extending from the forest line to a point about three miles below Vesuvius,Virginia, a distance of at least 6 miles. A total of 10 unmarked brook trout, 6 marked rainbow trout which had been planted in the experimental section above in 1935, 32 marked rainbow planted in 1936, and 22 unmarked rainbow trout were captured and measured. Of particular interest were

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[2]Embody, G. C.
1927. I. Stocking policy for the Genesee River System. A biological survey of the Genesee River System. State of New York Conservation Department, Albany, pp. 1-5.

(1) the small number of brook trout in the total catch and the complete absence of marked individuals, (2) the large proportion of marked rainbow trout which had been planted in 1936 and had wandered several miles downstream out of the section in which they had been planted and into South River, a stream containing smallmouth black bass, (3) the presence of a few rainbow trout marked in 1935 indicating that the same thing might have happened with this plant, and (4) the occurrence of an unusually large proportion (37 per cent) of fish 8 inches or more in length among the unmarked rainbow trout.

Table 1. Stocking and recovery of brook and rainbow trout in the St. Mary River 1935 to 1938[1]. (Plantings of brook trout were made between the upper falls and the source except on October 7, 1938, when they were planted in the entire stream. All plantings of rainbow trout were made between the forest line and upper falls.)

Item	Brook trout			Rainbow trout			
	Planted 9/26/35	Planted 11/10/36	Planted 10/7/38	Planted 8/26/35	Planted 8/13/36	Planted 10/20/36	Planted 11/10/36
No. planted	2,841	787	1,106	2,632	2,038	1,380	323
Av. length (in.)	3.75	5.00	5.60	5.00	4.20	5.50	6.00
No. recovered 1936	11	---	---	4		---	
Av. length (in.)	6.78	---	---	7.50		---	
No. recovered 1938	8	10	---	10		68	
Av. length (in.)	6.95	7.83	---	8.85		7.88	
No. recovered 1939	---	---	96	5		56	
Av. length (in.)	---	---	6.68	8.75		8.29	
Total no. recovered	19	10	96	19		124	

[1]A total of 11,107 fish of both species was planted, 268 were recovered and the percentage of recovery was 2.4.

Catch records on St. Mary River are probably about as complete as it is possible to obtain.[3] There is only one road up the stream valley, and the mountain slopes are so steep and rocky that it is exceeding rough work and nearly impossible to enter the stream from any other direction. One checking station located about one-fourth mile above the forest line served adequately to contact fishermen entering and leaving the stream. Two men furnished by the U. S. Forest Service were alternated at the station to contact the anglers. One man worked from daylight until noon and the other from noon until dark. All fish were measured and weighed at this station. Anglers using live bait were required to fish with barbless hooks. There were no restrictions on artificial lures.

Fishing under special permit was first allowed in St. Mary River during the period May 15 to June 15, 1936. Two hundred nineteen anglers (table 3) spent 1,469.8 hours catching 237 trout of which 179 were brook and 58 were rainbow. Of the brook trout, only 86 were actually the legal size of 7 inches (fork length) established for the species during 1936. The balance were undersized trout for which the anglers had allowed an abundance of leeway for shrinkage. A total of

[3]Messrs. Harold L. Borden, M. C. Howard, Thomas H. Brown and Talbot E. Clark, as well as other employees of the U. S. Forest Service, provided assistance in the field.

Table 2. Comparison of the number of trout planted in the St. Mary River with the number recommended by Embody (1927) for a B-1 stream. (The areas where the fish were planted are indicated in table 1.)

Item	Brook trout			Rainbow trout	
	Planted 9/26/35	Planted 11/10/36	Planted 10/7/38	Planted 8/26/35	Planted 8/13;10/20; 11/10/36
Length of section (miles)	5.875	5.875	9.000	3.125	3.125
Average width (feet)	7	7	8	9	9
No. planted per mile	484	134	123	842	1,197
Av. length fish planted (in.)	3.8	5.0	5.6	5.0	5.2
No. per mile recommended by Embody	614	516	491	663	663
Length (in.) recommended by Embody	4.0	5.0	6.0	5.0	5.0

Table 3. Summary of angling statistics with reference to brook trout and rainbow trout in the St. Mary River, 1936, 1938 and 1939[1]

Item	General Information		
Calendar year	1936	1938	1939
Open season	5/15 - 6/15	4/20 - 5/25	4/20 - 5/20
Number of angler's reports	219	188	167
Total number fishing hours	1,469.80	1,021.50	816.00
Average hours per angler per day	6.71	5.43	5.14
Total number of trout caught	237	299	439
Number of marked trout caught	15	96	157
Number of wild trout caught	222	203	282
Average number per hour	0.16	0.29	0.51
Number of hours to catch one fish	6.21	3.41	1.95
Average number per angler per day	1.08	1.59	2.63
	Brook trout		
Size limit (inches fork length)	7	7	6
Total number caught	179	111	279
Average length (inches)	7.4	7.7	7.1
Average weight (grams)	--	77.44	61.13
Average weight (ounces)	--	2.73	2.16
Condition factor	--	37.11	38.05
	Rainbow trout		
Size limit (inches fork length)	8	7	7
Total number caught	58	188	160
Average length (inches)	8.6	8.3	8.4
Average weight (grams)	--	98.53	108.76
Average weight (ounces)	--	3.46	3.84
Condition factor	--	38.46	40.15

[1] No fishing in 1937 because of a closed season.

Table 4. Composition of trout catches obtained by angling in St. Mary River

	Dates	Brook trout				Rainbow trout			Total no. trout in catch
		1935	1936	1938	Unmarked	1935	1936	Unmarked	
Actual number in catch	April 7, 8,	26	5	----	33	6	36	24	130
Percentage total catch	1937	20.0	3.8	----	25.4	4.6	27.7	18.5	---
Percentage composition (each species)		40.6	7.8	----	51.6	9.1	54.5	36.4	---
Average fork length (in.)		5.6	5.7	----	6.4	7.1	6.1	7.4	---
Actual number in catch	May 26, 27,	25	11	----	61	12	47	39	195
Percentage total catch	1937	12.8	5.6	----	31.3	6.2	24.1	20.0	---
Percentage composition (each species)		25.8	11.3	----	62.9	12.2	48.0	39.8	---
Average fork length (in.)		5.7	5.8	----	6.2	7.3	6.0	6.9	---
Actual number in catch	July 13, 14	19	15	----	48	2	36	18	138
Percentage total catch	1937	13.8	10.9	----	34.8	1.5	26.1	13.0	---
Percentage composition (each species)		23.2	18.3	----	58.5	3.6	64.3	32.1	---
Average fork length (in.)		6.2	5.6	----	5.7	7.8	6.2	7.0	---
Actual number in catch	November 10,	14	----	----	53	1	40	21	129
Percentage total catch	11, 1937	10.8	----	----	41.1	0.8	31.0	16.3	---
Percentage composition (each species)		20.9	----	----	79.1	1.6	64.5	33.9	---
Average fork length (in.)		6.6	----	----	6.3	8.8	6.8	8.0	---
Actual number in catch	August 31,	4	----	2	78	---	2	73	159
Percentage total catch	September 1,	2.5	----	1.3	49.1	---	1.2	45.9	---
Percentage composition (each species)	1939	4.8	----	2.4	92.8	---	2.7	97.3	---
Average fork length (in.)		6.6	----	5.8	4.8	---	7.9	6.2	---

15 marked trout, (11 brook and 4 rainbow) were turned in at the checking station. A current idea is that trout planted in the fall when about 5 inches long will attain legal size by the time of the opening of the trout season. Results obtained disproved this common notion.

Angling was so poor that the fishing season was not reopened during 1937. Instead, it was decided to conduct a study of the trout population with our own personnel in order to secure evidence on the growth of the planted fish which had been marked by fin clipping. Two-day excursions were made early in April, late in May, in July, and in November 1937. Sampling was conducted by angling principally with artificial lures, although bait and barbless hooks were also used. The

Figure 5. The third or lower falls of the St. Mary River.

fish were handled as carefully as possible, so that they could be returned to the stream in good condition. The results obtained, together with data for an excursion on August 31 and September 1, 1939, are presented in table 4.

On the four trips in 1937, 592 fish were examined, of which 310 were brook trout and 282 rainbow trout. No marks were found on 195 brook trout and 102 rainbow trout. The marked brook trout planted in 1935 greatly predominated (84:31), while the 1935 group of rainbow trout lagged far behind the 1936 group (21:159) which made much the best showing of any group. The dearth of 1935 rainbow trout may be due to a migratory habit in this species, or may mean that it does not withstand severe floods such as that of March 1936 as well as brook trout.

The numbers and average length of the marked and unmarked trout are shown in table 4, while figure 7 depicts the growth of marked trout. The 1935 brook

trout increased from an average length of 5.6 inches in April to 6.2 inches in July, and 6.6 inches in November. In numbers taken, this class of brook trout slowly declined, so that in November about one-half as many were obtained as in April. The 1936 brook trout were scarce in the April collection and increased steadily until July, when their numbers in the catches approached the 1935 fish, but none were found in the November collection. In April the 1936 fish averaged 5.7 inches; in May, 5.8 inches; and in July only 5.6 inches. Apparently, the numbers caught were insufficient to give representative average length.

The rainbow trout of the 1935 planting (table 4) were not numerous in any collection. The few taken indicate a fair growth for they averaged 7 inches in

Figure 6. Sampling the trout population of St. Mary River by angling.

April, 7.6 inches in July, and 8.75 inches in November. Rainbow trout of the 1936 planting grew from 6.0 inches to 6.8 inches between April and November 1937. Brook trout planted in 1935 were well represented in these series of collections and grew from 5.6 inches to 6.6 inches.

Fishing improved little during the 1938 season (table 3) when 188 anglers caught 111 brook trout and 188 rainbow trout after fishing 1,021.5 hours. A good part of the increase in the take of rainbow trout undoubtedly was due to the reduction in the legal size to 7 inches during 1938, although the average size dropped only 0.38 inch below the average for 1936 when 8 inches was the size limit for this species.

A large waste has occurred in planting fingerling trout in this stream (table 1). Of 11,107 trout of both species planted, only 268 or 2.4 per cent have been

recovered thus far by anglers. Table 4 and figure 7 show the slow rate of growth of planted trout. Naturally spawned trout are on the increase in the St. Mary River (table 4). The 1939 angling results also indicate a sharp increase in the abundance of naturally spawned or wild rainbow trout. Table 1, for example, shows that only 29 out of 3,628 brook trout planted prior to 1938 were recaptured. The 96 marked brook trout caught in 1939 were mainly trout that had been planted during the previous fall and they were slim and colorless fish. The bulk of brook trout caught therefore had been produced through natural propagation and there is no doubt that the wild brook trout in the stream grew more rapidly than those planted. The slow growth of introduced fish illustrates why the planting of fingerling trout has proved largely a failure. These facts challenge those in charge of the distribution of trout to pause and investigate further before wasting additional fingerling trout.

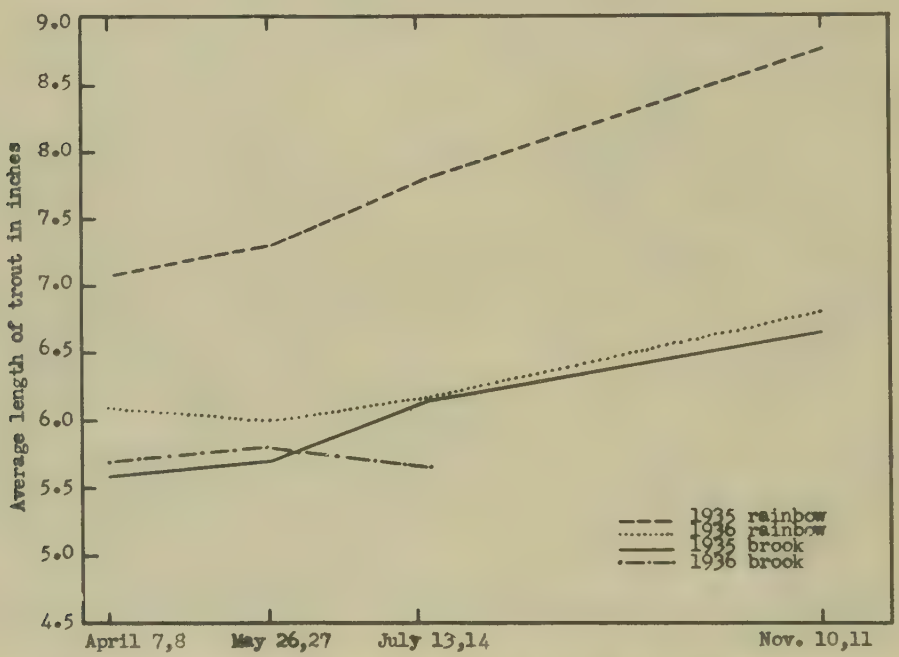

Figure 7. Growth of marked trout planted in St. Mary River in 1935 and 1936. Average lengths on specified dates in 1937.

Data collected in St. Mary River give further weight to the increasing body of evidence that brook trout do not migrate, even though they disappear, for very few brook trout marked and planted above the upper falls were taken below, and no marked brook trout were captured below the lower boundary of our experimental area prior to 1938.

SUMMARY AND CONCLUSIONS

1. The poor results of planting fingerling trout in St. Mary River are discussed. A recovery of 2.4 per cent from a total planting of 11,107 fingerlings has thus far been made.

2. A study of physical conditions shows that St. Mary River within the Big Levels game management area and for a distance of at least 1 mile below the area

boundary is suitable for brook trout. The maximum temperature during a year of continuous observation was 68° F. Shelter and pool conditions are probably better than average for the George Washington National Forest as a whole.

3. Chemical analysis revealed that St. Mary River water is very soft and averaged only 4.69 p.p.m. of methyl-orange alkalinity in terms of calcium carbonate. It is a slightly acid stream having an average pH of 6.8.

4. There were 231 days in a year during which temperatures ranged between 47 and 68° F. Trout have practically no opportunity for growth in the spring prior to usual opening of the Virginia trout season about April 15. This fact does not mean that the trout do not eat before April 15,or even during mid-winter.

5. Bottom organisms in riffle samples averaged 1.07 grams wet weight (0.25 gram dry) per square foot during the period August 1935 to August 1937. This amount of bottom fauna production represents average richness but borders on the poor (less than 1.0 gram is considered poor). The data (not included in this paper) indicate that late spring and early summer are periods when bottom organisms are least abundant. Trout planted in the fall or early spring would find bottom foods most abundant. The severe flood of March 1936 apparently did not damage the bottom fauna severely, although stream organisms were less abundant during the period immediately following the flood than during the succeeding year.

6. The food found in the stomachs of 37 brook trout and 14 rainbow trout taken from anglers' catches during the period May 15 to June 15, 1936, were examined microscopically. These examinations showed (a) a numerical predominance of terrestrial over aquatic food animals, (b) that crayfish are apparently important food organisms, (c) that rainbow trout, unlike brook trout, eat quantities of algae, (d) that rainbow trout seem to have a greater preference for aquatic forms of food than brook trout, and (e) that nematode parasites were abundant in all trout stomachs in the collection.

7. A study of the results of planting large fingerling brook and rainbow trout revealed a staggering waste. Of 11,107 marked trout planted since 1935, only 268 or 2.4 per cent have been recovered. These studies reveal (a) a very slow growth rate for stocked fish, (b) a downstream movement of rainbow trout, (c) an increase in the abundance of brook and rainbow trout resulting from natural propagation, (d) a general diminution in numbers of planted trout, even brook trout, which appear to stay pretty well where they are planted.

8. The stocking of fingerling brook and rainbow trout in St. Mary River has not resulted in any improvement in the abundance of the population. Further stocking of fingerlings in this or other similar streams in the region does not appear to be advisable.

CORRECTION

The name of Robert O. Smith, Assistant Aquatic Biologist, Beaufort, South Carolina, was omitted inadvertently from the directory of employees of the Bureau of Fisheries published as a supplement to the January - February 1940 issue of the PROGRESSIVE FISH-CULTURIST. Mr. Smith's name should be inserted on page S-7 under Oyster Cultural Investigations.

FIFTH NORTH AMERICAN WILDLIFE CONFERENCE

The Relationship between Commercial and Sport Fishermen[1]

By Charles E. Jackson
Acting Commissioner, Bureau of Fisheries

A NOTED AMERICAN sports writer, who is also a devout game-fish angler, recently referred to "the commercial-minded Bureau of Fisheries." Executives of commercial fishery firms have frequently charged the Bureau with overemphasizing the recreational features of its work, to the detriment of our more important responsibility--conservation and utilization of food fishes. I like to think that both groups are right; for therein both charges are answered--conclusive proof that the Bureau of Fisheries divides its responsibilities about equally between food and game fishes.

The Bureau of Fisheries is not commercial-fish minded, it is not game-fish minded, but it is fish-conservation minded; and the term conservation means, in our definition, wise utilization, whether it be for recreation or for food uses. This has been the policy of the Bureau since its founding and remains so today--three-quarters of a century later. It is more especially a binding policy now, since we have come under the aegis of a Department whose secretary, Mr. Ickes, has declared himself irrevocably bound to carry out a program of conservation of all our national resources.

I have recently analyzed the 1939 expenditures of the Bureau. It appears that out of our total appropriation, we spent close to $50,000 more to improve the sportsman's lot than for the commercial fisheries. I can easily understand,

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[1]Delivered at the Fifth Annual North American Wildlife Conference, Tuesday, March 19, 1940.

however, that a cursory review of our annual report on the propagation and distribution of fishes among the Bureau's 110 major fish-cultural stations may leave the reader with an erroneous impression. For instance,we boast of an annual production of 8 billion fish and eggs. In the breakdown of varieties, however, 7 billion of these show up as of commercial species as against only 1 billion of game species. Thus, quite naturally, the sportsman gets the idea that we are apparently more interested in the commercial than in the game species.

The actual facts, however, are these. Commercial species, with the exception of lobsters, are all planted in the fry stages, are not fed in our hatcheries, and in most cases are planted when only a few days old. The cost of production, therefore, is insignificant when compared with that of game fish which are distributed as fingerlings, in 6 to 9-inch sizes, a factor necessitating more expensive feeding, larger water areas, and of course a longer period of retention in the rearing units.

Briefly, the cost of producing commercial fishes averages $21 per million; game species, $6,146! About four-fifths of our fish culture appropriation is expended for the production of game species. Besides, the billion game fish planted in fresh waters of the country really come nearer meeting the demand than the 7 billion commercial species planted in commercial waters.

Our figures, therefore, can be easily misinterpreted. They merit a closer analysis by the sport fisherman if he wishes to get the true picture. As a matter of fact,practically every variety found in the coastal and inland waters is sought at some time or place by the hook-and-line fishermen for recreation; the hatchery contribution to recreation, therefore, would consist of billions of semi-game as well as strictly game fish.

This groundless charge of favoritism toward the industry comes, broadly, from the sport fishermen,an ever-increasing legion whose strength in influencing public opinion far outweighs that of the commercial group. Look, for illustration, at these figures. For the past five years the number of commercial fishermen shows no material increase; they stayed at about 130,000. The number of anglers taking out fish licenses during the same length of time, however, has grown from 4 3/4 millions in 1933 to 7 1/2 millions in 1938.

Nor does this vast army of anglers include the salt-water game-fishermen (except in California),small boys and girls, the thousands of humble hook-and-line fishermen,the women anglers, and the countless others from groups in various states who are exempted from taking out licenses.

It seems to me that a conservative estimate of anglers in the United States would easily reach 15 million; and,even if it may be that only a fraction of these are organized into active clubs, the several hundreds among them who are leaders in their communities and have strong political influence constitute a most powerful factor in molding public opinion.

The commercial group, although comparatively small, also wields considerable influence, raises lobby funds and, when necessary, makes an effective fight to protect what they consider their interests. At present, however, the commercial fishermen are not well organized, nor have they ever been, except those small groups interested in some single species--salmon or sardines, for example.

The Bureau of Fisheries needs the benefit of the combined influence of both groups of fishermen. This is essential, if we are to have true conservation. So that fishermen may not jump to wrong conclusions, the facts about any given fishery must be made known and properly interpreted. It has proved not too difficult for the angler, at times, when his catch decreased, to publicly place the blame on commercial fishermen, and through his organization, backed by its great numbers and valuable contacts, entirely eliminate the commercial fishermen from certain areas. In some past instances this has been done without full knowledge of the conditions prevailing; resulting in unemployment, and creation of bitter feelings, and even in some cases backfiring to the detriment of the supply of game fish.

There was this experience in Louisiana, for example, related by Percy Viosca. Some years ago, a number of lakes full of game fish were closed by local police power against all forms of commercial activity, supposedly to protect the game fish from the depredations of these fishermen. There was little poaching; the anglers saw to that themselves. There was a noticeable decline in the game fish catch each year, however, and soon angling was hardly worth while. Investigation revealed that the shallow waters in these particular lakes contained almost nothing but microscopic vegetation. Turtles were abundant; the lakes were overrun with buffalo fish, gars and carp. The anglers had removed only game fish, leaving their competitors and enemies to breed and grow unmolested.

When soon after, however, a plan was initiated whereby commercial fishing rights were leased to responsible fishermen, and the funds thus provided used to pay special wardens and to improve both game and commercial fishing, a balance grew up in the waters between the game and commercial species. Thus the war between the anglers and the commercial fishermen was settled in a way immensely profitable to both.

This experience but emphasizes the need for devoting more thought and study to the ecological relationships of game and coarse species, where the latter may dominate waters otherwise admirably suited to the development of an abundant game fish fauna. Prohibiting all catch of the coarse species upsets nature's balance, which certainly could not be restored in favor of the game fish by the planting of innumerable fry and fingerlings.

I believe with Viosca that "a well-regulated commercial fishery, working hand in hand with the anglers and their game fish restoration program is the only answer."

Annually since 1871, the Bureau has been collecting detailed statistics on the commercial fisheries, and these accumulated data supply one of the most important working tools of our biologists in determining the trend of a fishery. Some of the states too have compiled similar important materials. Practically nothing has been done, on the other hand, to obtain statistics of the sport fishery, and no appropriations are available to our Bureau for this purpose.

Recent information compiled by several states with the aid of sport clubs and angler groups on a limited number of species has, however, given us some conception of sport fishery statistics. Many of the results are amazing, and show conclusively that some way must be found to obtain these data if fishery biologists of the present and future are to have an index of the trend of the fisheries, for too often the available commercial statistics give only half the story.

Recently there was published by the New York State Conservation Department "A Biological Survey of the Salt Waters of Long Island." This survey was a cooperative project with the Federal Bureau of Fisheries. One table shows that the commercial catch of winter flounders for 1938 was approximately 645,000 pounds, comprising about one million fish.

During the same period, the recreational catch also amounted to approximately one million fish. This figure was compiled from information supplied from the charter-, open-, and rowboat fisheries, which cater to the general public through the hire of, or passage on, these boats; but does not include any record of catch by anglers on private craft, nor individuals who came to the beach by private transportation. The recreational catch of winter flounder, therefore, is shown at least equal to the commercial catch, even though only a portion of the sportsman statistics were available.

Tagging experiments of 1937, on the same species in Great South Bay, Long Island, showed that of the total number of returns within a two-year period after tagging, 14 per cent were made by the commercial fishery, and 24 per cent by the sports fishery. A 1938 experiment in the same area revealed, after one year, that returns of the commercial fishery were 23 per cent, and of the sport fishery 27 per cent. Thus there would appear to be little doubt that, if we had complete statistics of the catch of winter flounders by the entire recreational activity for Long Island, it would exceed the catch of the commercial fishery of 1938.

From the State of Washington comes a report that the sportsmen are rapidly increasing their take of chinook salmon in the inside waters of Puget Sound. In 1938 the commercial fishermen took about 51 per cent of the chinooks, the sport fishermen, about 49 per cent. In 1939 the sport fishery for chinooks increased to 58 per cent, while the commercial fishery fell off to 42 per cent. And here again, while complete statistics are available on the commercial catch, only a portion of the sport fishery catch is available.

Dr. John Van Oosten, a noted authority on the Great Lakes fisheries, writes:

> "Although we have no statistics to support our statement, yet it may safely be said that in some areas the angler takes out of the Great Lakes more poundage of certain varieties of fish than does the commercial fisherman. For example,it is believed that the sportsmen take more pike,rock bass, saugers, smelt, white bass, yellow perch, and walleyed pike out of Lake Michigan than are taken by commercial fishermen. With the rapid development during the last two years of deep-sea trolling for lake trout,it was learned that in at least one important locality,the anglers' catch of this species exceeded that of the entire commercial fishing fleet operating at this port."

Again, according to R. V. Truitt, Director of the Chesapeake Biological Laboratory:

> "Approximately 200,000 sportsmen fished with hook-and-line on the Bay during 1936. Statewide records for 1937 and 1938 indicate that between 290,000 and 300,000 persons went for each of those years to Maryland's marine fishing grounds to try their game-fish luck. Some 630 boats are employed in the activity, either full-time or part-time on a commercial basis; and hundreds of others carry private parties for which no records are available. Employment is given to more than a thousand persons on the water directly engaged as guides or boatsmen."

From these illustrations it may be seen that the sport fishermen, at least in some cases,are not justified in placing the blame for depletion entirely on the commercial fisherman.

Fresh-water trout from the mountain streams, black bass and certain other fresh-water species are not subject to commercial use and are reserved solely for the game fishermen. I am not referring here to these species, for commercial fishermen are not seeking to share this catch. I am concerned solely with species that are now shared by both commercial and sport fisheries, where the interests of the two groups in reality are identical, insofar as the conservation of the supply is concerned. If management practices are adopted that will maintain the supply at a high enough level of abundance to afford profitable commercial fishing, there will be enough fish for the angler also. Only in cases where faulty management is practiced, and the supply allowed to diminish, is there controversy between the two groups.

Proper management does not usually mean the elimination of either type of fishing, but means rather the adoption of regulations which will permit the supply to recover and to be maintained at a stable level. There are situations, however, in which controversy may arise between the commercial fishermen and the anglers which has no relation to the conservation of the fish themselves. Wise utilization of the supply frequently involves a decision as to the best means of utilization--that is, the use of the catch to yield the greatest benefit, either in terms of economic income or the satisfaction of all other legitimate demands.

There are local cases where the protection of the supply solely for the use of anglers is the wisest course, since this may yield the greatest revenue and the greatest benefit. But too often the demands of anglers for the limitation or prohibition of commercial fishing are hidden behind a smoke screen of conservation. In such cases the Bureau of Fisheries cannot support restrictive measures where no conservation interests are involved, but recognizes that such matters must be decided by the individual State legislatures on the basis of economics and social justice.

Public opinion is essential if adequate progress is to be made in solving the many problems of the American fisheries, but it is vitally important that public opinion be directed for the benefit of the public at large, and not merely for a privileged class of citizens. It is for this reason that I appeal to you both--anglers and wildlife conservationists--for a proper understanding of this important problem--this urgent need to stop now a growing tendency on the part of some ill-advised anglers to encourage dispute between the two groups.

The Bureau recognizes that there are abuses in the commercial fishery. Along our Atlantic Coast the pound nets, the trawl nets, and other forms of commercial gear are taking too great a toll of undersized fish. The Bureau is trying to solve this economic problem by experimentation, by education, and finally with the aid of the States by regulation. In the haddock fishery, for example, material progress has already been made in the design of saving gear, with larger meshed nets that permit the escapement of immature fish. In this case the commercial fisherman has long erred; but he now shows a desire to put the new gear into use, realizing that a small fish that demoralizes the market and constitutes a waste today will one year hence bring him a substantial profit.

Not until the sport fishermen and the commercial fishermen understand that fish conservation is one and the same problem for both groups will those of us charged with the responsibility of protecting the American fisheries have the full benefit of increased personnel and adequate appropriations to bring about the fullest use of a valuable natural resource which, under our form of government, belongs to <u>all</u> the people.

Every citizen has an equal right to the use of fish, whether it be taken in a net, or on a hook. Mrs. Kelly, who lives with her five children in the tenement district of one of our large cities, has no patience with the angler, a full-grown man who wades a trout stream all day engaging in pleasant recreation, or the surf angler who casts his line into the sea. Nor is she much concerned with the commercial fisherman who may be struggling with the elements in his ice-coated fishing schooner. But she is vitally interested in buying inexpensive fish to feed her family. The clinic doctor has told her that little Pat and little Maureen need protein fish food, rich in vitamins, to avoid rickets, to strengthen their bones, harden their teeth. And Mrs. Kelly and all the little Kellys are as much entitled to the use and enjoyment of fish as you and I, though none of them may ever experience the thrill of taking a fish from the water.

Let me repeat then, my chapter and verse: The Bureau of Fisheries is not commercial-fish minded, it is not game-fish minded, but it is fish-conservation minded, and is exercising to the utmost its authority, its personnel, and its funds for the wise conservation and utilization of all fish for all Americans.

Abstracts Of Selected Papers

The Fifth North American Wildlife Conference was held under the auspices of the American Wildlife Institute March 18, 19 and 20 in the Mayflower Hotel, Washington, D. C. Technical sessions on fishery problems were held Monday afternoon when 11 papers on stocking policies were presented, and on Tuesday afternoon when 10 papers on the measurement of fish populations were read. Drs. T. H. Langlois and C. McC. Mottley presided over the Monday and Tuesday sessions respectively.

Through the courtesy of Mr. C. M. Palmer of the American Wildlife Institute, copies of the papers presented at the two technical sessions on fish management were made available for abstracting. The PROGRESSIVE FISH-CULTURIST presents herewith a selected series of abstracts prior to publication of the full proceedings of the conference. With one exception in which the authors' summary was available, the abstracts were prepared by H. J. Deason of the Bureau's staff.

EXPERIMENTS ON THE STOCKING OF FISH PONDS

H. S. Swingle and E. V. Smith
Alabama Agricultural Experiment Station
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Experiments have been conducted over a five-year period upon methods of stocking ponds for the most efficient production of fresh-water fish. These experiments have been conducted in ponds ranging in size from 0.5 to 12 acres. Ponds

were stocked in various ways during the winter or early spring and the results determined, after an interval of one or more years, by draining the ponds and counting and weighing the fish.

Stocking with adult fish (a combination of bluegills,white crappie, yellow bullheads, and largemouth black bass) gave extremely poor results. This procedure resulted in overcrowding the pond with some species and in the total failure of others to reproduce.

Stocking ponds only with bluegill bream fingerlings resulted in rapid growth of the bream until spawning occurred. Growth then ceased entirely, due to the increased competition for food by the thousands of small fish produced. Very few fish ever reach a legal size in ponds stocked in this manner.

Stocking ponds with various combinations of bluegill bream and white crappie gave better results, but usually resulted in the ponds being overstocked with either bream or crappie, or both.

Stocking ponds with a combination of bluegill bream fingerlings and largemouth black bass fingerlings gave the best results, measured by the growth of both bream and bass. In these ponds, the bass had reduced the numbers of small bream and small bass, leaving approximately the right numbers for rapid growth. Good results were secured only by the addition of the correct numbers of fingerlings of both species; the basis upon which these numbers are calculated is given.

Properly stocked ponds provide good fishing within less than a year, while improperly stocked ponds have required as long as five or more years to reach this condition.--Authors' Abstract.

AN ANALYSIS OF FISHING IN THE T.V.A. IMPOUNDMENTS DURING 1939

R. William Eschmeyer and Clarence Tarzwell
Forestry Relations Department
Tennessee Valley Authority

The paper presents a detailed analysis of 34,270 usable creel-census records representing a catch of 98,495 fish. The study covers the fishing activities on Norris, Wheeler and Wilson Reservoirs during 1939. Some of the general conclusions of the study are mentioned below.

The catch differed decidedly in the various waters considered, for game fish predominated in the reservoir and tailwaters but in the flowing portions of the river pan fish outnumbered the game fish. Fishing was similar in various portions of the storage reservoir and fishing intensity depends primarily on accessibility.

A closed season during spawning season is recommended for the storage reservoirs. On run-of-the-river reservoirs, however,year-round fishing should be permitted for most species, but closed seasons should be enforced for species that

show a decline in catch. Commercial fishing should be encouraged in run-of-the-river reservoirs but only hook-and-line fishing should be permitted in storage reservoirs.

The construction of more dams will tend to improve fishing in the waters below since the water tends to become clearer through the deposition of silt in the reservoirs. Erosion control has a benefit on fishing because it tends to clear the water and make it more productive.

Fishing in the Tennessee and Clinch Rivers has increased decidedly since the completion of the T.V.A. impoundments.--H.J.D.

AN EFFICIENT SAMPLING METHOD FOR TAKING A CREEL CENSUS

C. McC. Mottley and D. R. Embody
Cornell University, Ithaca, N. Y.

The increasing use of a creel census to obtain a measure of the exploitation of angling resources has prompted the discussion of the relative effectiveness of sampling methods. The cost of obtaining a total census is prohibitive for most investigations and therefore the whole must be judged on the basis of partial coverage. The blind assumption that any arbitrary method of sampling will afford adequate and representative results is erroneous. Three criteria must be considered in the evaluation of sampling methods: representativeness, adequacy, and cost. The paper attempts to solve the question, "By what sampling method can an efficient estimate of the total catch of fish from a particular body of water be made?"

Three methods of sampling are recognized and defined: haphazard, periodic, and random. Haphazard sampling, often confused with random sampling, is useful only in preliminary exploration but its methods are not scientific. The efficiency of six sampling methods, three periodic and three random, was tested through an analysis of data obtained during a 5-year creel census of Paul Lake, British Columbia. The representativeness, adequacy and cost of the various methods were determined by statistical analysis.

The principal variation of random sampling is known as stratified random sampling. The whole season, for instance, may be divided into shorter periods, e.g., 2 weeks. Within each 2-week period certain days may be selected. The days are selected by numbering each day in the fishing season and drawing sufficient numbers from a table of numbers such as that of Tippett. (Tippett, L.H.C. 1927 Random Sampling Numbers. Tracts for Computers XV. Cambridge). The numbers drawn indicate the days on which the census is to be taken.

After an adequate analysis of the data it was concluded that:

1. "Random sampling is the only representative method. Hence calculations

of total yield and comparisons of yields in different years can be made only from values derived by this method.

2. "A method of restricted, stratified random sampling, using a design for an analysis of variance provides the only efficient method of the three studied for comparisons between years.

3. "Restricted, stratified sampling having the lowest cost per unit of information is the most desirable on the basis of cost."--H.J.D.

THE FORAGE RATIO AND ITS USE IN DETERMINING THE FOOD GRADE OF STREAMS

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Although valuable information concerning feeding habits may be obtained from an analysis of stomach contents, the information so obtained may not be an index of the kinds and relative numbers of food organisms present in the environment. The kind and amount of food eaten results from the interaction of fish and environment and both should be studied.

The study is based on a collection of 90 black-nosed dace (Rhinichthys a. atratulus) and 10 random samples of bottom organisms from the same section of Cascadilla Creek. For this species the kinds and relative numbers of organisms in the stomach did not, necessarily, indicate the qualitative nature and relative abundance of bottom organisms.

The term "forage ratio" is proposed as a measure of the relationship between the feeding habits and the organisms in the environment and is defined as "the ratio of the percentage which a given kind of organism makes up of the total contents to the percentage which this same organism makes up of the total population of food organisms in the fishes' environment." The percentages may be calculated from numbers, volume or weight. Numbers were used, although volume or weight might be preferable.

Differences in the forage ratios of the various organisms are due to availibility rather than preference. Some organisms, although abundant, are too large to be eaten. Others, of secretive habits, may be difficult for the fish to capture.

The usual method of determining the food grade of streams is based on the total number of organisms in the environment, regardless of their value as food organisms. A new method of determining the food grade is proposed.

Only the organisms that constitute 1 per cent or more of the stomach contents should be considered food organisms. Sufficient samples should be studied so that the standard error will be within 10 per cent of the mean. The organisms with a

forage ratio of 1 or more should be given their full values. Those with a ratio less than 1 should be given a value equal to the forage ratio times the mean number or quantity per sample. The total number or quantity of organisms that results from the series of calculations will constitute the food grade of the stream as applied to the particular fish for which the forage ratios were determined. Food grade determined in this manner should be called effective food grade.

Effective food grade will differ according to the species of fish, age and size of the fish, and the season of capture.--H.J.D.

MEASUREMENT OF FISH CATCH IN THE RUSSIAN RIVER

Oliver T. Edwards
U. S. Forest Service

The Russian River, situated in the Chugach National Forest, Alaska, is a famous and widely advertised rainbow trout stream. Because of the small size of the river, the concentrations of sportsmen, the use of gaff hooks and spears during the spawning season, and heavy angling throughout the entire fishing season, the fishing intensity is great. The abundance of rainbow trout is reported to have declined rapidly during recent years.

A creel census conducted from May 17 to August 8, 1939, provided statistics on the catch in Russian River. The activities of 358 fishermen resulted in the capture of 1,710 rainbow trout and 154 Dolly Varden trout. An average of 4.1 rainbow trout was taken per fishermen over the period of the census. The best fishing was between July 15 and 31 when an average of 6.1 rainbow trout per fisherman was taken and the poorest period was from May 17 to 31 when the average number was only 1.7. By far the largest fish (average 26.6 in.) were taken from May 17 to 31 which was the interval of the lowest average catch and the rainbow trout captured during the interval of the largest average catch, July 15-31, were of the smallest average size (11.9 in.). The maximum size of rainbow trout varied little throughout the season as the largest fish in two-week periods were between 30 and 34.5 in. in length.

Recommendations have been made for a prohibition of fishing during the spawning season, a reduction of bag limits, and absolute prohibition of all fishing methods except rod and line. The annual compilation of catch statistics by means of standardized creel-census forms has been urged.--H.J.D.

CONTROL OF GAR FISH IN LOUISIANA

James Nelson Gowanloch
Louisiana Department of Conservation, New Orleans

Four species of gars, the Mississippi alligator gar (Atractosteus spatula), the long-nosed gar (Lepisosteus osseus), the spotted gar (L. productus), and the short-nosed gar (L.platostomus), inhabit the waters of the Gulf states. All are extremely predacious and destroy large quantities of valuable game fishes.

In Louisiana the gars spawn in March when they ascend the bayous into very shallow water. The ovaries of one individual 49½ inches long weighed 8 1/3 pounds. On the basis of an actual count of ten 1-gram samples of eggs it was calculated that this individual had produced 340,000 eggs. Contrary to popular opinion, the gar is quite palatable when properly prepared,although the eggs are highly poisonous.

Control of the gars became necessary in Louisiana to conserve game species. Because the body of the gar is fairly rigid and cannot be flexed sharply it was possible to construct a trapping device that would retain them but would release any game species caught at the same time. In experimental observations the trap device was inserted in the first chamber of a two-crib hoop net, 4½ feet in diameter. The game fish escaped from the trap and passed into the second compartment of the hoop net from which they were removed, counted and released. The gars were retained separately by the trap device in the first compartment. Counts of the fish captured by the device in two twelve-hour sets consisted of 10 gars in the first chamber and 42 game fish in the second chamber in one instance and of 9 alligator gars and 1 turtle in the first chamber and 22 game fish in the second.

While the complete elimination of gars is not a feasible project their control by a trapping device gives satisfactory results. The trap may be used successfully in conjunction with pound nets, trap nets, hoop nets or seines. The device is simple and the total cost estimated at thirty cents.--H.J.D.

THE FISH POPULATION OF A SMALL POND IN NORTHERN ALABAMA

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Boddie Pond, Lauderdale County, Alabama, had an area of 1.78 acres, a shoreline length of 1,013 feet, and an average depth of about 1.4 feet, at the time the fish population was removed by poisoning with derris. The pond is in a red clay area that has been subject to rather severe erosion; consequently the pond was heavily silted.

The pond contained only three species of fish, the brown bullhead (Ameiurus nebulosus marmoratus), the yellow bullhead (A. natalis natalis), and the golden shiner (Notemigonus crysoleucas). A total of 2,145 bullheads were removed that had a total weight of 313.5 pounds. Brown bullheads were about 3 times as numerous as yellow bullheads. The population of golden shiners totalled 20,112 and the total weight was calculated as 77.4 pounds.

The food of 46 yellow bullheads consisted of 63.9 per cent mayfly larvae, 21.2 per cent corixids, 4.83 per cent golden shiners, and the balance of a trace of oligochaetes and representatives of 13 insect orders in minor quantities. The food of 41 brown bullheads consisted of 83.9 per cent insect larvae, 7.9 per cent corixids, 0.4 per cent golden shiners, and the balance of a trace of oligochaetes and representatives of 5 insect orders in minute quantities.

Age, length range, average weight and condition were determined for 3,470 golden shiners. Fish during their first summer of life constituted 94.6 per cent, second summer fish, 5.0 per cent, and the balance consisted of individuals in their third, fourth and fifth summers.

The total population consisted of 176 pounds of bullheads per acre, 33 pounds per acre of golden shiners, or a total productivity of 219 pounds per acre. Measured in terms of pounds per million gallons the productivity was bullheads, 389; golden shiners,96; total 485. A comparison of the results with other productivity data shows that in general,southern waters have a greater productivity than northern waters. Hence, southern waters can stand a heavier fishing strain. Overpopulation is not confined to northern waters.--H.J.D.

THE ESTIMATION OF A BREEDING POPULATION OF CHUB SUCKERS

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A study of the abundance of chub suckers (Erimyzon oblongus oblongus) in a breeding population was conducted in a pond near Cincinnatus, New York. Fish were captured by means of 1-inch mesh fyke nets and after length measurements were recorded and scale samples taken they were released. The removal of scales constituted the marking that permitted the identification of recaptured fish. The data on recaptured fish were analyzed by a mathematical method proposed by Schnabel. The conclusion was reached that the total breeding population in the pond was 317 ± 58 individuals. The population consisted principally of fish 4,5, and 6 years old and the males of each age group averaged larger than the females. Growth was rapid for the first three or four summers but very slow thereafter. Ninety-nine males and 128 females were captured. The probability that the population contained slightly more females than males was 19 to 1.--H.J.D.

After the Hatchery - What ?

A SPORTS WRITER POSES A QUESTION FOR FISH-CULTURISTS[1]

By Roy Wall

THE ARTIFICIAL propagation of fishes, like many other scientific operations, has traveled a long, rocky road since the early days of its infantile beginnings. Like much of civilization's early profundity of reasoning, the origin of pisciculture, or fish culture, may be traced to the Chinese. Later, in the fourteenth century, a European monk succeeded in artificially hatching fish eggs. About the middle of the eighteenth century a Prussian army officer, Jacobi, was successful with numerous experiments in fish culture and in 1851 the French government became so impressed with the work of two Lorraine fishermen,Remy and Gehin, that a hatchery was established at Huningen. The success of the French hatchery spread quickly to America and two years later,in 1853, Dr. Garlick began artificially propagating fish in this country.

In the year 1871, as a result of the interest engendered by Dr. Garlick's activities, Congress provided for a commissioner of fisheries and Prof. Spencer Baird was appointed to the position. Perhaps to Prof. Baird goes the credit of establishing fish culture in this country until today every state is now vitally interested in the business of raising all the fish possible, that is, if one does not look back of the political smoke screens.

Conceivably, the science of artificial fish propagation, as it is now practiced, has attained a high degree of success and no knowing person would dare gainsay its importance to the fishery business of the country. And yet I am wondering if we have not been misled, to a great degree, into thinking that the planting of artificially propagated fishes was a panacea for all of our fishing ills. Have we not let the fish-culturist headline the show long enough? Certainly it is not enough just to hatch fish fry unless we know something of what becomes of this planted fry. In short, what is the survival percentage? Civilization is so speeding up the evolution of our fishable waters and at the same time demanding larger fish crops each year that it would appear to me, if my observations have been reasonably accurate, that food and water surveys, stream and lake improvement and ecological balance are now imperative.

For example, I have studied the fishing waters of one state for the past 15 years and have seen splendid trout streams cease to be trout streams because of erosion, decaying vegetation and the subsequent high water temperatures. And yet these streams have been stocked continually with trout. You have only to fish them, however, to know that the survival of the trout planted was nil. This same state boasts of the great number of fish planted in its waters, 2,000,000,000 annually,I believe, and yet the fishing is appreciably on the decline. The critics of such a program declare that the 2,000,000,000 fish are "paper fish" that never see the water - that the politicians give these figures to a gullible public. However true these charges may or may not be, there is one thing certain, the fish might as well be "paper fish" so far as improved fishing goes, if the restocking of unsuitable water continues.

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[1]Reprinted with permission from "Our Woods and Streams" in the Wichita, Kansas, BEACON,Oct 1,1939.

HATCHERY DIETS AND GROWTH

EXPERIMENTAL STUDIES OF THE GROWTH OF BROOK TROUT[1]

By C. M. McCay and
the staff of the Cortland Hatchery
Cortland, New York

IN HATCHERY EXPERIMENTS it is important to understand thoroughly the nature of any variables that might affect the results. Experiments conducted at Cortland to determine the course of growth in fish of different origin fed on the same diet and on groups of fish of the same origin fed the same diet but held in different troughs have afforded some rather striking results.

GROWTH OF THREE STRAINS OF BROOK TROUT

From the practical viewpoint it is desirable to use trout that possess at least average growing abilities for feeding experiments. With this in mind, growth studies were conducted using three strains of brook trout, two from commercial trout growers and one from the Craig Brook Station of the U. S. Bureau of Fisheries in Maine. The groups of trout ranged in number from 23,738 at the start to 291 at the end of the experiment, were fed the same diet, and similar amounts of food in terms of percentage of the body weight. They were held in troughs at the same weight per cubic foot of water. Although the fry did not start feeding at the same time, the fact that the water temperature remained constant at 47±0.5° F. offset this disadvantage. The dates of initial feeding of the three strains were January 20th, March 3rd, and March 31st. The diet consisted of 50 per cent beef liver, 48 per cent pig spleen and 2 per cent salt. The experiment was conducted for a period of 32 weeks and the growth of the three strains during this time is presented in table 1.

Table 1. Percentage increase in body weight of brook trout for 4-week periods.

No. of weeks	Lot No.		
	300	301	302
4	154	134	130
8	152	151	150
12	108	130	129
16	108	106	89
20	84	63	77
24	52	57	57
28	54	52	42
32	38	37	58
Average gain	94	91	91

[1]Abstracted from the Annual Report of the Cortland Hatchery to the Division of Scientific Inquiry, U. S. Bureau of Fisheries. The hatchery is a cooperative project operated by the following, who jointly prepared the report: C. M. McCay, Cornell University; A. V. Tunison and A. M. Phillips, New York Conservation Department; and C. R. Mitchell and E. O. Rodgers, U.S. Bureau of Fisheries.

The amount of selective breeding carried on in the production of the eggs for the three lots is not known. It is interesting to note that there is no difference in growth of the three strains even though one started to feed more than two months in advance of the others.

SOURCE OF PROTEIN AS A FACTOR IN BROOK TROUT GROWTH

Protein is the most costly nutrient of the diet and is derived from either animal or plant sources. Protein of such organs as the liver and heart is considered of good quality. Milk is one of the best sources of protein. Fish meal if properly manufactured at low temperatures and with a minimum of bony material is a good source of animal protein. Plant foods generally fall into two classes, the cereals and the protein concentrates. Cottonseed meal is one of the leading plant concentrates which is used as an animal feed and wheat flour middlings, a cereal by-product, is usually found in the farm animal rations. Dried skim milk, fish meal, cottonseed meal, and wheat flour middlings have been used as dry feed supplements to a meat diet for trout for several years with success. How well trout utilize the protein of these ingredients is not known. This year experiments were designed to study protein utilization using trout growth as the indicator.

The composition of the diets employed is shown in table 2. Each diet contained pig spleen and salt, and all but one contained raw starch. The other items were the variables in the diet.

Table 2. Percentage composition of diets employed to study the growth of brook trout.

Item	Diet				
	1	2	3	4	5
Pig spleen	50.00	50.00	50.00	50.00	50.00
Salt	2.00	2.00	2.00	2.00	2.00
Dried skim milk	25.00	--	--	--	6.25
Cottonseed meal	--	20.00	--	--	5.00
Whitefish meal	--	--	13.00	--	3.25
Wheat flour middlings	--	--	--	48.00	12.00
Raw starch	23.00	28.00	35.00	--	21.50

The pig spleen and salt acted as a binder and at the same time furnished the fresh meat factor as well as part of the protein. The various amounts of the milk, cottonseed meal, fish meal, and middlings added enough protein to that of the spleen so that the total protein for each diet was 29 per cent. Raw starch was used to make up the balance of the diet.

The experiments were conducted for a period of 24 weeks. Brook trout were used in the trials and from 3,810 to 465 fish were used during the course of the experiment on each diet. Each group of trout was fed the same amount of food in proportion to its body weight and all the fish in each group were weighed periodically. The average percentage growth rate for each group during this time is given in table 3.

Table 3. Percentage increase in body weight of brook trout for 4-week periods that were fed diets containing different sources of protein.

Diet No.	Variable protein source	Percentage increase in body weight
1	Dried skim milk	60
2	Cottonseed meal	50
3	Whitefish meal	60
4	Wheat flour middlings	49
5	Mixture	61

The data for the 24-week period when treated statistically show the animal protein is superior to that derived from plant sources. Similar results were obtained with the dried milk and fish meal and with the cottonseed meal and middlings. A mixture of these ingredients did not improve the growth obtained with the separate animal proteins.

VARIATION IN GROWTH OF SIX GROUPS OF BROOK TROUT

In the past nearly all of our feeding experiments have been run with single troughs of trout. In practical feeding trials and experiments the groups of fish were fed the various diets for periods of from 12 to 24 weeks since we believed that such a time interval would eliminate the errors resulting from the individual variability of trout. However the question of running experiments in duplicate or triplicate has arisen at different times. In order to judge the soundness of this technique an experiment was designed which we hoped would answer some of these questions.

The experiment comprised six groups of brook trout having an average weight at the beginning of 0.71 grams. The groups were started using 1270 fish in each and were fed a diet composed of pig spleen, 50 per cent; salt, 2 per cent; dried skim milk, 12 per cent; cottonseed meal, 12 per cent; whitefish meal, 12 per cent; and wheat flour middlings, 12 per cent. The amount of food allowed each group was calculated at the beginning of each weighing period and at the end of 24 weeks each group had received 12,042 grams of food. The cost of this diet was $4.18 per hundred pounds. The fish were weighed at two week intervals and the average weight of the fish for each period is presented in table 4.

From these data the percentage gain in body weight was calculated for each group and these percentage gain values were treated statistically by means of analysis of variance. Since the variability of the growth of trout might differ with body size the data for the first 12 weeks of the experiment and the data for the last half were treated separately as well as the data for the whole 24-week period. The pertinent data resulting from this analysis are shown in table 5.

A statistical analysis of the data of table 5 demonstrated that there was no significant difference in the percentage gain in weight of the six groups of brook trout during the first 12 weeks of the experiment. During the last 12 weeks there was a statistically significant difference between the extreme values of 18 per cent for Group 329 and 22 per cent for Group 327 (the extremes of variation). With reference to the entire period of 24 weeks, one group, No. 327, was out of line, but there were no significant differences among the other five groups.

Table 4. Average weight in grams of brook trout fed the same diet for a period of 24 weeks.

Date	Group No. 326	327	328	329	330	331
March 31	0.71	0.71	0.71	0.71	0.71	0.71
April 14	1.07	1.06	1.01	1.01	1.02	1.03
April 28	1.50	1.46	1.42	1.46	1.46	1.43
May 12	1.91	2.09	1.95	1.97	1.85	1.93
May 26	2.61	2.87	2.66	2.75	2.61	2.70
June 9	3.54	3.96	3.58	3.69	3.51	3.62
June 23	4.55	5.20	4.60	4.75	4.60	4.66
July 7	5.09	5.84	5.23	5.30	5.20	5.35
July 21	6.44	7.48	6.56	6.46	6.55	6.77
August 4	8.00	9.65	8.10	7.96	8.16	8.25
August 18	9.46	11.90	9.76	9.40	9.96	9.82
September 1	11.70	14.50	11.70	11.30	12.30	11.90
September 15	13.30	17.10	13.60	13.00	14.70	14.20

Table 5. Mean percentage gain in weight of six groups of brook trout during the first 12 weeks, the last 12 weeks, and the entire 24 weeks of the feeding experiments.

Period	Mean percentage gain No. 326	No. 327	No. 328	No. 329	No. 330	No. 331
First 12 weeks	36	39	36	37	36	37
Last 12 weeks	19	22	20	18	21	21
Entire 24 weeks	28	31	28	28	29	29

It appears therefore that when feeding experiments are conducted with the larger sized fingerlings such trials should be carried on for periods greater than twelve weeks or that more troughs should be used for each variable. In view of these data we might also add that when relatively small differences are to be determined, a series of troughs should be devoted to each variable, or if fewer troughs are used the experiment should be continued for a longer period.

DENVER, COLORADO.- Totals of 4,825,000 brook trout eggs were shipped during the 1939 season from the federal hatchery maintained at Leadville, Colorado.

Two and one-quarter million brook trout and 1/4 million Loch Leven trout fry are being cared for at this hatchery.

During the early part of February, approximately 1 1/2 million eyed brook trout eggs were shipped to several western hatcheries for incubation and eventual distribution in nearby waters.

Formalin Treatments Pass New Tests

ADDITIONAL NOTES ON THE CONTROL OF ECTO-PARASITIC PROTOZOA

By Frederic F. Fish
U. S. Bureau of Fisheries
Seattle, Washington

AFTER THE COMPLETION of the experiments reported recently[1], in which the efficacy of formalin in controlling infections of Costia necatrix was demonstrated, the author was afforded an opportunity to test the value of formalin solutions in combatting established mixed infections of Gyrodactylus, Trichodina, (Cyclochaeta) and a stalked protozoan on rainbow trout fingerlings. This opportunity was provided through the courtesy and cooperation of Clarence F. Pautzke, Chief Biologist for the Washington State Game Department, and Lee Walters, Superintendent of the Washington State Hatchery at Seward Park, Seattle.

Briefly, the technique employed was standard for this type of prolonged treatment. Two hundred fingerling trout were placed in each of three small experimental troughs, the capacity of which had been calculated at 86,788 cubic centimeters. To administer a treatment, the requisite amount of formalin was thoroughly mixed in a pail containing 13,200 cubic centimeters of water - due allowance being made for the water in the pail when estimating the quantity of formalin required. Following the initial dilution of the formalin, the water supply to the trough undergoing treatment was stopped, the drain tightly plugged, and the diluted formalin solution spread evenly about the trough. No aeration was attempted during the course of treatment. At the end of one hour the drain was opened and the water supply resumed.

To check the quantitative efficacy of each treatment, three fish were preserved in 10 per cent formalin for subsequent parasite counts immediately before the treatment was administered and a duplicate sampling was made twenty-four hours after the treatment.

The results obtained in these field experiments were as shown in the accompanying table.

It was impossible to make a quantitative count of the stalked protozoans present on the fish prior to the treatment. However, none of these parasites were found on the fish subsequent to treatment with any of the formalin dilutions.

In a sample taken for comparison from a hatchery pond in which all fish had received the conventional two-minute dip in a 1:500 solution of glacial acetic acid, an average number of 28 Trichodina and of 25 Gyrodactylus was found 24 hours after treatment.

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[1] Fish, Frederic F.
Formalin for External Protozoan Parasites. The PROGRESSIVE FISH-CULTURIST, No. 48, January-February 1940.

Relative efficacy of formalin solutions in removing ecto-parasites from rainbow trout

Experiment No.	Trough No.	Formalin-Conc. Used	Average number of parasites per fish			
			Immediately before treatment		24 hours after treatment	
			Trichodina	Gyrodactylus	Trichodina	Gyrodactylus
A	1	1:4,000	26	38	0	0
	2	1:4,000	94	43	0	0
B	1	1:4,000	32	184	0	0
	2*	1:4,000	29	96	0.3	0.6
	Untreated control		142	99	34	189
C	1	1:5,000	31	58	1	3
	2	1:5,000	98	79	0	0.3
	Untreated control		237	73	299	37
D	1	1:6,000	21	67	1	2
	2	1:6,000	?	?	0	1
	Untreated control		100	26	21	36

*Received 53-minute treatment.

We now have accurate quantitative experimental evidence that every ecto-parasitic disease of hatchery trout and salmon can be prevented effectively by the routine application of a simple and safe formalin treatment which costs one-third the price of salting - heretofore considered the most economical form of hatchery treatment. We also have definite proof that formalin treatments are completely effective and, of equal importance, that the usual treatments now recommended are not.

There is one outstanding external bacterial disease - the so-called eastern type of gill disease - upon which we have no data concerning the value of formalin treatments. Unfortunately this disease is so rare in this region that we have had no opportunity to work with it since the development of formalin treatments last spring.

CHEYENNE, WYOMING.- Thirty-four tons of ice which will be used this summer in the distribution of fish were cut and stored at the Saratoga station of the Bureau of Fisheries.

A consignment of 205,820 Loch Leven trout eggs was received from a commercial fish-cultural establishment at Troy,Montana. The fish resulting from these eggs will be used in the filling of Wyoming applications.

For the last three years the Bureau has been unable to furnish many fish of this species for the stocking of waters in that locality, due to the fact that the take of Loch Leven trout eggs in the Madison Valley - the point the Bureau has relied on to furnish its supply of eggs of this species - has been very small.

STUNNING FISH BY ELECTRICITY

ELECTRIC SHOCK PROVIDES METHOD OF ANESTHETIZING FISH IN LABORATORY

By David C. Haskell
State Fish Hatchery, Gansevoort, New York

ELECTRIC SHOCK produces an anesthetic effect on fish. This effect has been used to develop a method of obtaining a fish census of streams.[1] The same principle may be used to quiet fish during laboratory procedures or manipulations such as tagging. The equipment required is very simple and inexpensive, and 110-volt alternating current from a light socket provides a suitable source of power.

A simple apparatus may be constructed as follows: Two untarred wire-cloth trough screens are fastened in a hatchery trough about 2 feet apart. Two wires are brought from an electric outlet, and one is connected to each screen. The fish to be stunned is placed in the water between the screens, and a switch in the electric circuit closed for a few seconds. In the water at the Gansevoort hatchery a 110-volt shock for 5 to 7 seconds produced a paralysis of 6-inch brook trout for about 2 minutes, when the screens were spaced 2 feet apart.

If the electric shock is to provide a controllable anesthetic effect, some precautions are necessary so that equal effects will be produced when a number of fish are subjected to the electric current simultaneously. First, the current path through the water must be so arranged that the stunning effect will be the same in all areas of the space between the screens. To make possible a simultaneous effect in all parts of the electrified area, the cross-section of the current path must have an area and shape equal to the cross-section of the electrode or screen. The hatchery trough with the two screens fulfills this requirement. It has been suggested that a galvanized washtub with the metal of the tub as one electrode and a small electrode dipped in the center would be convenient for this work, but the idea has been rejected because it provides a non-uniform electric field and would not produce consistent effects.

A second important point is to confine the fish in such a way that its body is parallel to the direction of the current flow. A different effective time of the induced paralysis will be obtained if the fish is placed parallel to the current path than if it were crosswise in the trough and perpendicular to the direction of current flow. The desired condition may be obtained if the trough is sufficiently narrow and shallow so that the fish cannot turn in it. For 6-inch brook trout a trough 3 inches deep, 2 inches wide, and 2 feet long is suitable.

For safety one other precaution is necessary. One of the two wires of the ordinary public-utility power lines has been grounded by the company. The grounded wire can be identified by connecting one of the power wires to one side of a lamp socket and grounding the other wire from the socket. If the lamp does not

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[1] Haskell, David C.
An electric method of collecting fish. Trans. Am. Fish. Soc., Vol. 69, pp.210-215,1940.

light then the wire being tested is the grounded one. If the lamp illuminates then the wire not tested is grounded. The grounded lead is connected to one screen. A socket and a lamp should be put in series in the lead that is not grounded between the power plug and the trough screen. The lamp should be large, 100 watts or more. With this lamp in the circuit an accidental grounding of one of the wires or of the screens cannot short circuit the power line, but will only light the lamp.

By means of the above method I recently stunned a total of 88 tagged 6-inch brook trout. The tag was removed and replaced by a larger one while the fish was stunned. The method was much easier for the operator, and probably caused less distress to the fish than if no temporary paralysis had been induced. Of the 88 fish, 2 died on the next day, but there was no further mortality during more than a month thereafter.

BOZEMAN, MONTANA.- Reestablishment of the Montana grayling in the West Gallatin River of Yellowstone National Park has been brought about by the planting of fingerling fish from the Federal hatchery at Bozeman, Montana. The initial stocking of the river took place in 1938 when 6,131 fingerlings, 4 to 5 inches in length, were planted. In the late fall of that year 15,000 graylings, 2½ inches in length, were added. A third lot of 5-inch grayling fingerlings were liberated in the upper part of the river during the spring of 1939.

The grayling, a native of Montana waters, once abounded in the Madison, Jefferson, and Gallatin Rivers. Myriads of these fish ascended the tributary streams of the Gallatin River during the spring spawning runs. Long journeys to these waters were made by the Indians for the purpose of catching the fish, which they dried and used for food in the winter.

With the arrival of the white man began the more or less wanton destruction of this splendid species,and soon the grayling was only a memory. The West Gallatin River, once famous for its grayling, became known for its wonderful trout fishing after rainbow and brook trout were introduced into its waters.

According to general reports from anglers, the Bureau's current activities in stocking the Gallatin are proving highly successful. Prior to this stocking, not a grayling had been taken from the river in over 30 years. During the past season, however, sportsmen landed scores of legal-sized fish.

Several attempts have been made during past years to stock these waters with grayling fry. In this stage, 400,000 grayling were planted here during the years 1920, 1921, and 1923. For some reason, the stocking of fry did not prove a success. However, the results secured from these early plantings plus the 1938-39 stocking indicate rather conclusively that the planting of larger fingerlings is the more productive method of stocking. It is thought that the species will now be able to maintain itself by natural reproduction, supplemented by limited plants of hatchery reared fingerlings.

THE VALUE OF DISINFECTION IN ULCER DISEASE

STERILIZING PONDS WITH CHLORINE PREVENTS RECURRENCE

By Louis E. Wolf
State Fish Hatchery, Rome, New York

DURING THE FALL of 1938 ulcer disease broke out in the New York State hatchery at Van Hornesville. This hatchery, devoted exclusively to raising brook trout, is only a few years old and had enjoyed a very fine record for low mortality and good health of fish. The entire water supply arises from a single large spring located on the hatchery grounds, so that conditions are ideal for prevention of disease and parasites. Nevertheless, ulcer disease appeared, and soon spread to all the fish on the place.

The writer has had numerous opportunities to study ulcer disease in hatcheries in which it had long been endemic, but this was his first opportunity to observe its course in virgin territory. It was decided, therefore, to adopt a policy of watchful waiting, and to see what course the disease would run.

The disease grew steadily worse. The mortality rate for the fingerlings which comprised the entire stock of the hatchery in the fall of 1938 is given in the first row of figures in table 1. By the beginning of February, 1939, it appeared that all the fish were doomed. Not only had the mortality risen to nine per cent, but the appearance of all the survivors seemed to preclude any hope of their recovery. All showed advanced symptoms of ulcer disease.

During February, therefore, all fish were disposed of, and preparations made to disinfect the hatchery. Because of excessive snowfall and the formation of huge snow drifts around some of the ponds, the disinfection had to be postponed until March 22, so that the ponds stood empty of fish, but full of water, for more than a month.

Chlorinated lime was used as the sterilizing agent. The writer was present at the disinfecting of the U. S. Bureau of Fisheries hatchery at York Pond, New Hampshire, and witnessed the very efficient use of liquid chlorine as described by Dr. H. S. Davis in the November-December 1938 issue of the PROGRESSIVE FISH-CULTURIST. For the present purpose, however, the use of liquid chlorine was decided against. The Van Hornesville hatchery, consisting of eleven small ponds, does not compare in size with the York Pond hatchery, and it was estimated that a single tank of liquid chlorine would be much more than was necessary. For such a small establishment the chlorinated lime seemed much simpler to use.

The lime came in 12-ounce cans, advertised to contain not less than 24 per cent of available chlorine. A total of 50 pounds was used. The contents of each can was stirred into a wooden tub full of water, and the mixture poured into the outlet of the main spring. This carried the chlorine solution through all the

pipes and into the ponds, which had been drained previously. The process was continued until all the ponds were filled, whereupon the spring water was diverted and the ponds allowed to stand with their content of chlorinated water. The water in each pond was tested with ortho-tolidine solution, as described by Davis, and, where necessary, additional chlorinated lime was added directly to the pond until the water exceeded five parts of chlorine per million. The solution was left in the ponds till the next day. Every net, boot, pail, pan, meat-room implement, and in fact almost every movable object on the place was thrown into the ponds and given a thorough sterilization. The next day the ponds were slowly drained into the stream below the hatchery without causing any loss of fish in the stream.

Table 1. Mortality rate of brook trout before and after disinfection of ponds. Mortality given in percentage dead each month.

	Sept.	Oct.	Nov.	Dec.	Jan.
1938-39 (before disinfecting)	0.06	0.70	1.400	7.300	9.000
1939-40 (after disinfecting)	0.10	0.03	0.005	0.003	0.005

A few weeks after this treatment the hatchery was restocked with fingerling brook trout. These fish did exceptionally well all summer and fall, and no signs of ulcer disease have appeared to date. The low mortality of these fish is shown in the second row of figures in table 1. At the present writing all fish look well, and it is confidently felt that the treatment administered in March completely rid the hatchery of the disease. Comparison of the two sets of figures in table 1 gives a true picture of the results of the disinfection.

Experience with ulcer disease in other hatcheries has shown that it can be quite as virulent as furunculosis. The results at Van Hornesville prove that it can be stamped out by the method described. At the present time no other method of dealing with the disease is known. In the opinion of the writer disinfection should be resorted to more frequently, both in cases of ulcer disease and furunculosis.

SACRAMENTO, CAL.- Because of heavy, intermittent storms, the creek from which the Battle Creek substation of the Bureau of Fisheries receives its water supply has been maintained at a very high level. This caused a large amount of silt to be carried into the hatchery, resulting in a heavy mortality among the small fry. Frequent cleaning of the screens in the settling tank was necessary both day and night during the heavy storms to prevent the water supply from stopping.

During the latter part of February, 2,469,550 fingerling chinook salmon were liberated in Battle Creek in the vicinity of the hatchery. The greater percentage of these fish should have been liberated earlier, but due to the continued high stage of the Creek, it was deemed advisable to hold them in the hatchery until the Creek had subsided to the point where the fish would not be in danger of stranding in pools outside of the regular course of the creek.

PLANTING FISH BY BOAT

By Robert Fortney
District Supervisor of Fisheries Operations
Michigan Department of Conservation

IN THE PARIS hatchery district there are two trout streams large enough, deep enough, and sufficiently lacking in serious obstructions to make possible the planting of trout by boat. The streams in question rank in the upper brackets of truly great trout streams. The Pere Marquette, named after the famous early explorer, is a consistent producer of heavy brown trout, with rainbow trout and an occasional brook trout filling in to make a diversified creel. The noted Pine, presumably named after the huge pine trees that grew so profusely along its banks, boasts but two species of trout, the brook and rainbow, but has maintained a proud record of production throughout the years.

The steel boat we have in use was built by an experienced boat builder in the winter of 1932 and was first put to practical use in September of that year on the Pere Marquette River. We have used it every year since in planting that stream. Although the boat is made in two sections and may be taken down for easier handling, we have not found it necessary to take advantage of this feature. A heavy-duty, homemade two-wheel trailer is used to transport the boat to and from the stream. Three used 4-inch grain binder rollers were inserted in the iron frame of the trailer, which allows the boat to be skidded onto the trailer with ease. We use a 50-foot piece of 1-inch rope to skid the boat out of the stream and to level ground for loading.

The material used in the construction of the steel boat was 20-gauge galvanized sheet metal and the bottom was crimped over the side and then soldered. The boat draws 10 inches of water when fully loaded. The weight of the bare boat is 660 pounds.

A size 2-A Redi-Prime pump, manufactured by the American Steam Pump Co., Battle Creek, Michigan, is used to circulate the water in the fish compartment. A screened slot, 2 x 6 inches, cut near the top of the compartment, takes care of the overflow. The plumbing is simple, as thepump rests on the bottom of the boat, near the 2-inch threaded pipe flange, which serves as the intake and uses

as a water supply the waters of the river itself. The Redi-Prime pump is not special equipment for this particular job, but is valuable and much used equipment around the hatchery and rearing ponds.

A skilled boatman, standing at the rear of the boat with a 12-foot pike pole and assisted from time to time by his helper, who plants the fish, may take a boat safely and without accident down the navigable rivers of this State. If he is not so skilled, it is well to have another semi-skilled man up front, also with a 12-foot pike pole.

No other method known to us ever can approach the efficiency of planting trout by boat. As many as ten thousand fingerlings from three to four inches

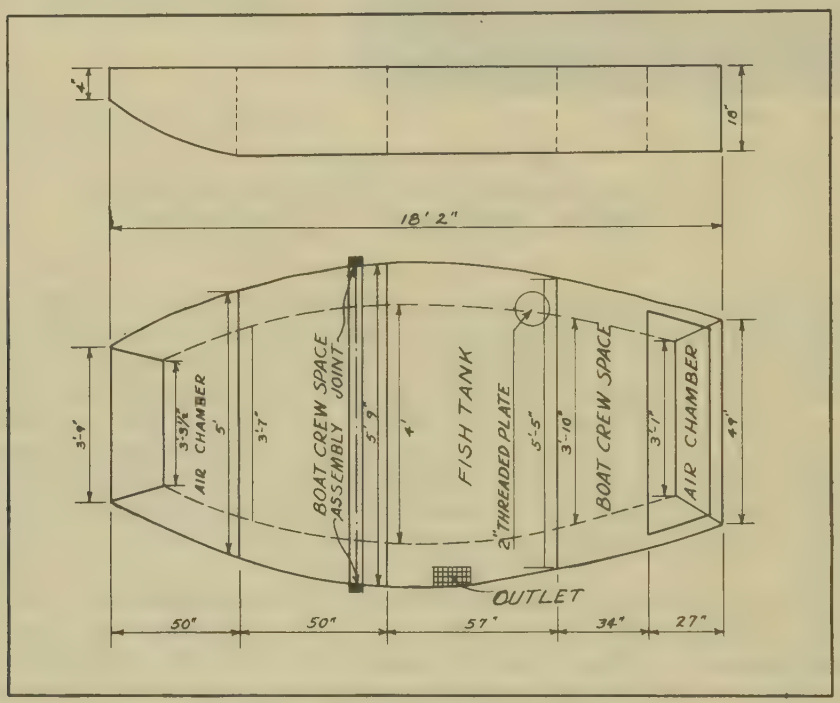


Diagram of steel boat for planting fish.

long may be carried at the start of a boat trip in the tank provided for that purpose. Since we make a practice of planting 5,000 trout of this size per mile we are able to cover about two miles of stream with the ten thousand fingerlings. The distance covered with each tank of trout, however, must of necessity be governed by the number and location of landing places accessible by planting unit or truck, which is kept in constant operation servicing the boat.

Two thousand 7- and 8-inch trout may be carried at the start of a trip, providing the circulating water system is used to provide oxygen and a constant change of water is flowing into the tank. Trout of this size are released one by one over a six-mile stretch, and one can appreciate what a thorough distribution like this means when trout are planted during the open season. A further advantage is the fact that available food supplies are more equitably rationed to the newly planted trout.

COMMENTS FROM OUR READERS

Another Note on Formalin and Costia

Editor, The PROGRESSIVE FISH-CULTURIST

The article on Costia and formalin by Dr. Frederic F. Fish in your journal for January and February confirms the work I did on Costia with formalin two years ago about which I wrote you. My method of investigating this subject was quite different from that employed by Dr. Fish and so much simpler that it may be of interest to others. It was essential in my case to get positive results at once and I could not wait for long tests. The method used was as follows:

Fry which had just absorbed the egg sac and were not fed were used for test. About 25 fry were taken for each experiment. They were treated and then kept in vessels which had been sterilized with chlorine and supplied with pure water free from any contamination. Salt was tried for 15 minutes in concentrations from 2 to 4 per cent. In each case Costia developed again in from two to three days showing that salt was useless in destroying the organism permanently. Acetic acid caused heavy mortality. Copper sulphate 1 to 2000 also caused some mortality and seemed to remove the Costia but evidently injured the vitality of the fish. Formalin was tried in concentrations from 1 to 2000 to 0.5 to 2000. Plehn recommends 0.7 to 2000 using the usual 40 per cent solution. . . .

As the Plehn concentration showed no bad effects on the fry in an hour I used 1 to 2000 and found that the fry stood this perfectly for an hour and the first sign of trouble became evident when the fry had been in this solution for 1 1/2 hours at 46° F. It was evident that if I used 15 minutes as the time that there would be an ample safety margin of at least 4 to 1 in time before any injury would result. I have always considered that such a safety margin was a necessity in any trout treatment. Fry treated 15 minutes with 1 to 2000 formaldehyde commercial solution did not show any Costia in two weeks and were completely freed from them by one treatment. There was no mortality at all. The following plan was adopted and has been followed in my hatchery for two years with all the fish. The tank or trough is drawn down to about two inches depth and the required amount of formalin to make 1 to 2000 when mixed in the tank is measured out and mixed in a large pail of water which is slowly dumped along the trough or in the tank with active stirring so as to get complete mixing at once. There has been no evidence of any effect from too high concentration and no mortality caused by the treatments. The fry or fish are left in this solution for 15 minutes and then the water is turned on and the formalin allowed to be diluted and washed away.

The results of this method have been surprisingly good for two years. Last year I kept about 30,000 fry in my hatchery troughs and tanks and they were all treated once a week by this method and also dipped 15 minutes in a 2 1/2 inch salt solution. The losses for the year were unbelievably small where they had often been excessive in previous years. My man is certain that he did not remove more than 200 to 300 dead fish during the year and nearly all of these were injured by the nets in moving them from one tank to another as we sterilize all the

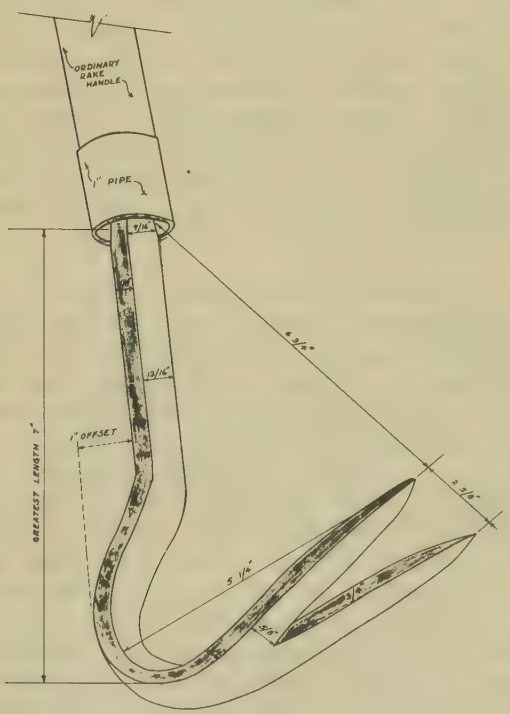
tanks with chlorine every week and scrub out any algae and slime from the bottom and sides as I have found that this slime is injurious to small trout and retards their growth. It is perfectly certain that raising trout in this way obviates all trouble with all the parasites I have known. There have been none in my hatchery and no trout disease for over a year now. . . .

Edward R. Hewitt
New York, N. Y.

An Aquatic Weed Puller

Editor, The PROGRESSIVE FISH-CULTURIST:

I am submitting herewith a drawing of an aquatic weed puller which I designed and forged from a piece of spring steel. We used this puller here at the station last fall for pulling the coarser weeds, and found it to be entirely satisfactory in every respect. Being designed to catch a firmly gripping hold below the crown, it is especially well adapted for removing duck-potatoes (Sagittaria) and weeds of like nature, which if grasped by the tops will usually break off, leaving the roots which soon send out new shoots. When tried on cattails, we found it to be a "go-getter." On grasses too, it worked efficiently. In fact, upon giving it a thorough test we found it indispensable.



Besides being, quite probably, unequaled for the purpose designed, it may be advantageously employed as a garden tool for cultivating and cleaning from underneath hedges and bushes, for lifting objects submerged or from the margin of ponds, and various other uses.

This tool can be made by any blacksmith in a very short length of time, and should prove to be a worth-while time and labor saver at any of the Bureau's stations, particularly where the coarser aquatic weeds are bothersome.

George C. Hollopeter
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NOTES AND NEWS

Experimental Propagation of Mullet

OVER FIFTEEN thousand salt water fish, consisting chiefly of the jumping or striped mullet, did not go south as usual this winter. Instead, they were forcibly detained in experimental tidal ponds constructed at the biological laboratory at Beaufort, N. C., maintained by the Bureau of Fisheries.

Two years ago these ponds were constructed in cooperation with the Works Progress Administration and the Conservation Department of North Carolina, in order to determine the possibility of utilizing salt marsh ponds and small coastal bays for rearing and live storage of fish and for oyster culture.

The experimental operations, conducted here since 1938 under the supervision of Dr. H. F. Prytherch, Director of the Beaufort Laboratory, have demonstrated that by improvement of tidal areas through the construction of dikes and sluice gates,for example, it is possible to grow mullet, spotted trout, flounders, channel bass, sheepshead, croakers, and several other common species in captivity; or store them in a live, healthy condition for many months until there is a favorable market. The ponds also proved satisfactory for protected natural spawning and rearing of the mullet, which is the most important food fish caught in the South Atlantic and Gulf States.

The production of the striped mullet in this region amounts to approximately 40 million pounds annually with a return to the fishermen of nearly 1½ million dollars. During certain periods when the markets are glutted with mullet, the temporary live storage of a considerable quantity in the coastal ponds would assist in maintaining better prices for the fishermen and making available a supply of fresh fish at any season of the year.

In the fall of 1938 the experimental ponds were stocked with over 3,000 fish, ranging in size from roe mullet weighing over 5 pounds to small immature fish havin a length of 6 to 8 inches, which were approximately one year old. The fish were captured with nets during their fall migration to southern waters, and were transported to the pond by means of a perforated boat or "live car," having a capacity of approximately 400 pounds.

Most of the mullet were placed in the larger tidal pond which has an area of approximately 2½ acres at low water, a maximum depth of 15 feet, and receives an exchange of over 5 million gallons of water daily through the two tidal gates. Several hundred of the immature mullet were placed in the smaller observation pond and in large concrete pools at the laboratory where they have been observed with respect to feeding habits and ability to survive low water temperatures during the past two winters.

The adult mullet apparently spawned in captivity during November 1938, for the pond was stocked with thousands of young which,by the latter part of December,

had attained a length ranging from 1/2 to 3/4 of an inch. Although no attempt was made to hold these young fish in the pond by use of fine mesh screen on the tidal gates there were, nevertheless, a considerable number which remained in the ponds and grew to an average length of over 6 inches during the first year.

Less than one per cent of the fish died from injuries sustained during collection and transportation, or during the subsequent period of 15 months that they were held in captivity.

Operations during the following year (1939) were conducted on a small commercial scale, using a special barge equipped with a built-in live box and water-circulating system capable of transporting 3,000 to 5,000 fish ranging in weight from 1/2 to 1 pound each. The catches of mullet were obtained from regular fishing crews who were able to transfer them with ease directly into the barge without exposing the fish to air for more than a few seconds. On arrival at the storage pond, the fish were released from the barge into a receiving lock from which they swam into the pond with the flood tide. A total of over 12,000 mullet were placed in captivity by this procedure, together with a few hundred specimens of other species such as croakers, spot, pigfish, and white perch.

No additional roe mullet were placed in the ponds in 1939, because it was important first to determine whether those held in captivity since the previous year had continued to grow and develop spawn to the extent that they would if free under natural conditions. A number of the largest fish were caught in October and November 1939, and examined as to quantity of spawn, for example, condition of the flesh, and growth rings on the scale. These specimens, ranging in weight from 2½ to 5 pounds, were found to contain ripe roe which weighed from 6½ to 12 ounces according to the size of the fish.

Experienced local fishermen expressed the opinion that these mullet were in as fine condition, and as fully developed with roe, as those being captured at that time in the commercial fisheries. Studies of the scales showed that the growth of the impounded fish had been considerable since their last winter spawning period and equivalent to that found in free individuals which had spent the previous summer in these waters.

The general results indicate, therefore, that ponds of this type can be used not only for growing mullet without artificial feeding, but also as natural marine hatcheries. The tidal flats and shallow areas in the ponds were also used successfully for oyster culture which, at the same time, improved conditions for production of the natural food of the mullet.

Fishery Biology - 400 B.C.

"These [the fishes] were made out of the most entirely ignorant and senseless of beings, whom the transformers did not think any longer worthy of pure respiration, because they possessed a soul which was made impure by all sorts of transgression; and instead of allowing them to respire the pure and subtle element of air, they thrust them into the water, and gave them a deep and muddy medium of respiration; and hence arose the races of fishes and oysters, and other aquatic animals, which have received the lowest habitations as a punishment for their extreme ignorance."--Plato

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REVIEWS

A COMPARATIVE STUDY OF THE LAKE TROUT FISHERIES IN ALGONQUIN PARK, ONTARIO
By F. E. J. Fry. University of Toronto Studies, Biological Series No. 46; Publications of the Ontario Fisheries Research Laboratory, LVIII, 69 pp., Toronto, 1939.

THE CREEL-CENSUS method has become one of the important tools for the biological investigation of fisheries that are prosecuted wholly or in part by angling. Unfortunately, in many instances, the general program has not been planned with foresight, and the actual collection of the census material has been so poorly executed and supervised that the conclusions are scarcely reliable. Dr. Fry's study demonstrates the type of information that may be obtained from the well-organized creel-census program that has been used on the lakes of Ontario's Algonquin National Park. Although the report has as its object the formulation of a management program for the lake trout fisheries of the Algonquin Park lakes, its most important contributions are to the field of methodology.

The comparisons of the yield of lake trout per unit area by commercial fishing and by angling constitute a challenge to those sportsmen who are inclined to believe that the effects of their own activities on the fish stocks are negligible and that the prosecution of commercial fisheries results in wanton destruction. Actually, with but one minor exception, Dr. Fry discovered that anglers captured considerably more lake trout per square mile and per acre in four lakes in Algonquin Park than commercial fishermen captured in five other lake trout waters. The results may not be strictly comparable because of possible differences in the productive capacities of the waters compared, although the general conclusion that the take of anglers may equal or exceed that of commercial fishermen is tenable.

Comparative studies of the length composition of the lake trout populations as determined by catches of graded mesh sizes of experimental gill nets and the catches of anglers are illuminating. In general, angling tends to draw principally upon the moderate and large-sized fish of a particular lake even though the population may contain comparatively few fish of those sizes. Since angling for lake trout is fairly selective, it is evident that creel-census records alone fail to provide an adequate concept of the age and size composition of a population. Seasonal variations in the size of fish taken by anglers were discovered and the causes are discussed.

The parallel behavior of ciscoes of Lake Nippissing and lake trout of Lake Opeongo with respect to feeding activity, migration and bathymetric distribution in different seasons is of interest. However, the extreme differences in the behavior of these species in other waters, notably in some of the Great Lakes where the two occur together, suggest that Dr. Fry's conclusions may not have general application.

Marked seasonal variations in the success of anglers in the same lake and in different lakes were noted. There was some relationship between availability, the anglers' catch, and fishing intensity on a given lake. The inability of a lake to withstand too intensive angling is strikingly illustrated by the retrogressive changes in angling success from 1936 to 1938 in Lake Opeongo. The degree of success not only diminished in each year as the season advanced, but also the actual catches per unit of effort progressively decreased throughout the three years.

The paper is replete with other details concerning the biology of lake trout and its relation to angling. These details cannot all be discussed in this brief review.

Some of the graphical representations in the paper are so complex that they are difficult to interpret. The reviewer does not subscribe to the method of smoothing data by running averages but prefers to see statistical information presented in terms of actual values.

Dr. Fry is well aware of the limitations and the possibilities of the creel-census method with reference to management studies. The paper should be digested carefully by all who are conducting creel-census work or who propose to do so. The success or failure of any program may be conditioned greatly by initial planning.

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(Continued from inside front cover)

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APPLICATIONS for this memo, which is distributed free on regular mailing lists, should be addressed to the Commissioner of Fisheries, Washington, D. C. Contributions for publication are welcome.

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NOTICE REGARDING CHANGE OF ADDRESS

IT IS THE AIM of the Bureau to maintain an up-to-date mailing list for THE PROGRESSIVE FISH CULTURIST and to record promptly requests for change of address. Owing to the method of filing address cards and maintaining the addressograph plates, it is important that anyone requesting a change of address notify this office of both the old and the new address.

PROGRESS IN BIOLOGICAL INQUIRIES, 1938

Fish-culturists who wish to keep abreast of the latest developments in their field and to evaluate the place of fish culture in the general program of fishery conservation will need a copy of PROGRESS IN BIOLOGICAL INQUIRIES, the current administrative report of the Division of Scientific Inquiry.

Following the introductory summary of recent progress in fishery biology, accounts are given of outstanding fishery problems in each section of the country and of current progress in investigations dealing with the management of marine fishery resources of the Atlantic, Gulf, and Pacific Coasts, the conservation of Great Lakes fisheries, the management of inland fishery resources, the protection of existing fish supplies from the effects of pollution, and the improvement of shellfish culture.

Of direct interest to fish-culturists, the section "Aquicultural Investigations" provides a condensed account of the trout and bass management studies carried on in all sections of the country during 1938. The development of stocking policies, experiments in the feeding of hatchery fish, and investigations of fish parasites and diseases are discussed.

PROGRESS IN BIOLOGICAL INQUIRIES, by Elmer Higgins, (Administrative Report No. 35) may be obtained for 15 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.